Analysis of NOAA IP Addressing

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Problem Statement

- Perception that NOAA Silver Spring / Suitland address space (140.90.0.0) is rapidly exhausting.
- Desire to migrate to ANS as primary ISP.
- IANA denial of requests for more IP network numbers.
- Need for plan to allocate CIDR block of 64 class C's received through last IANA request.

NIST Tasking

- Develop quantitative basis for discussing current and future NOAA address allocation and management schemes.
- Examine issues related to perceived problems.
- Develop preliminary recommendations for resolving problems.
- Facilitate NOAA discussion and closure on one or more solutions.

The Routing Problem

- The issue of migrating to ANS as the primary ISP for DC can be separated (to some extent) from addressing issues.
- The goal should be to use ANS as primary ISP while maintaining direct connectivity with NASA/NSI sites of interest.
- This does not require the use of NASA/NSI as the primary ISP for DC.
- Similar arrangements already in use (ERL)

ANS / NASA Routing

- Migrate to ANS announcement of 140.90.0.0 and appropriate other nets.
- Exchange routes (full NSI, or partial) with NASA to permit direct NSI-to-NOAA connectivity.
- Lack of current routing arbitration will preclude use of fallback routes (both NSI and ANS announcing NOAA-DC).
- Manual switch over to cover outages.

Effects of Use of ANS as ISP

- Heavy Suitland-NASA traffic will still use NSI gateway in Suitland.
- Only Suitland-to-Internet and SSMC-to-NSI/Suitland traffic will cross FNS network.
- SSMC ANS router should be directly attached to FNS to avoid Internet transit traffic on SSMC backbone.
- NASA/NSI would have no problems with the change.

The Addressing Problem

- Past NOAA deliberations on this topic have been less than productive due to lack of commonly known quantitative data on the current situation.
- NIST's objective is to provide a quantitative basis for discussions and deliberations.
- Two pronged approach:
  - » Survey NOAA network administrators
  - » Analyze address utilization through the DNS.

Written / EMail Survey

- NIST developed a survey to determine current usage of IP address allocations, future requirements, and address management capabilities.
- Further goal of survey was to explore the complexity of any potential address changes / reallocations.
- Survey distributed March 22, 1996.

Survey Results

- To date, very limited response.
  - 10 replies
  - Covering a small portion of NOAA subnetworks
- Some observations:
  - Very little automation of IP address allocation / assignment.
  -

DNS Analysis

- NIST developed software to exhaustively explore the DNS (both Name and Address space) and compute statistics on IP address allocation and use.
- Primary output consists of a series of WWW pages to facilitate NOAA review, discussion and update.
- http://snad.ncsl.nist.gov/~dougm/Consulting/NOAA/noaa.html.

DNS Analysis Program

- Collection of “C”, shell (sh), and Perl programs that recursively walk NOAA DNS space and compute IP address usage statistics.
- Tabular / graphs output to WWW pages.
- “DNS-CRUNCH” operates in two modes:
  - » Search the DNS space of a set of “Known Resources” (domains, networks).
  - » Analyze the DNS zone files found in search.

Limitations of DNS Analysis

- Data collected can be misleading if:
  - » Large #s of hosts are not in DNS (AWIPs).
  - » Large #s of DNS entries for non-existent hosts.
  - » DNS protocol/server errors.
  - » DNS zone file errors.
  - » Initial set of “Known Resources” incomplete.
- Must verify that DNS data provides a level of coverage suitable for the task at hand.

Initial Uses of DNS-CRUNCH

- Initial runs of DNS-CRUNCH have found:
  - 99 NOAA Networks (6 Bs, 93 Cs)
  - 419 NOAA subnetworks.
  - 9775 NOAA Hosts.
  - 190 NOAA Domains.
- DNS-CRUNCH computes address space utilization statistics for NOAA networks.
- The program is careful to only count unique interface address / domain names.

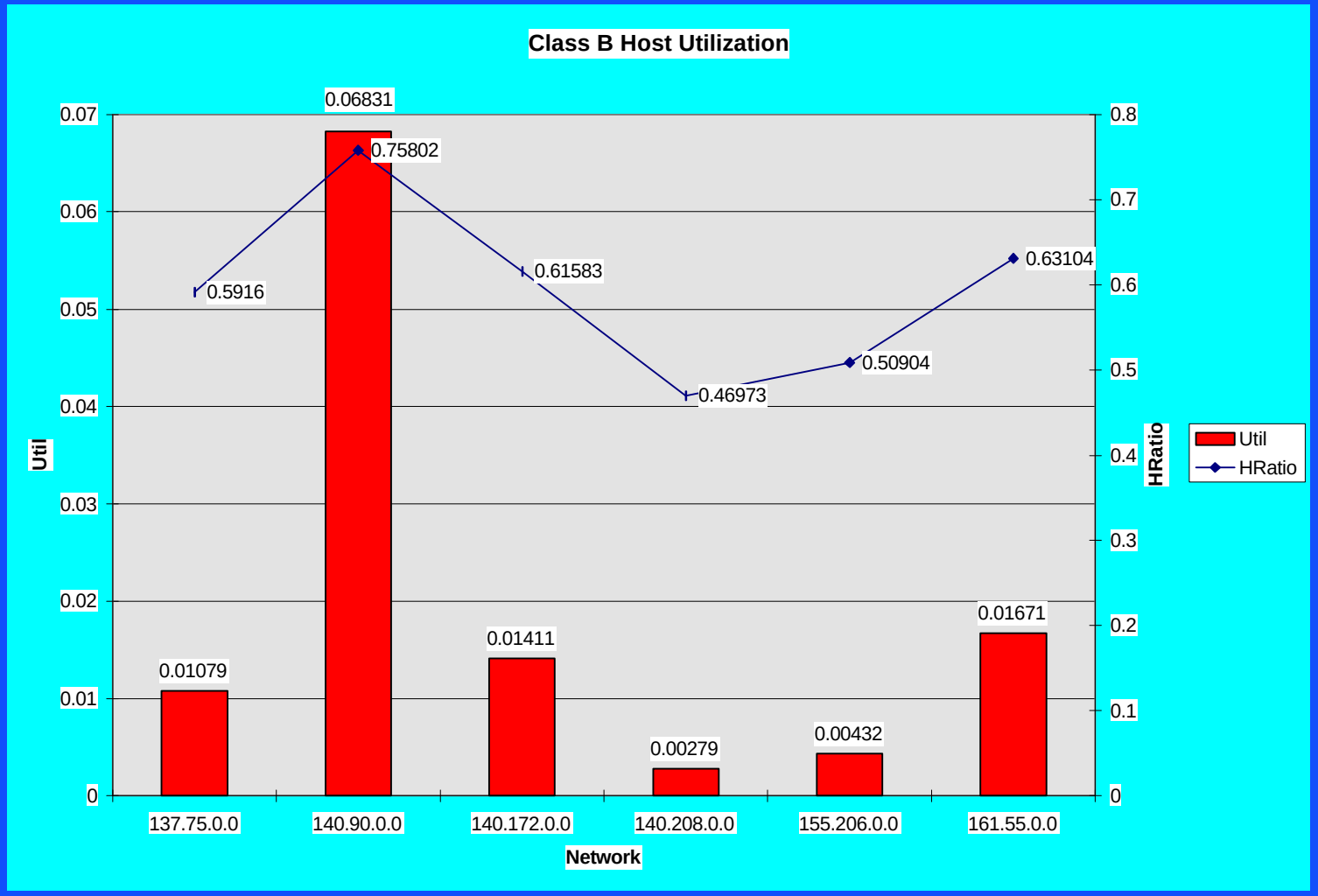
DNS-Crunch Statistics

- SubNets - Logical IP subnets. Class C = 1
- SNUtil - % utilization of current SN field.
- Hosts - Really “interface addresses”.
- AvgSN - Average # of hosts per subnet.
- Util - % utilization of host field (ignoring subnetting).
- HRatio - Log scale utilization of host field.
- Domains - # of DNS domains using net.

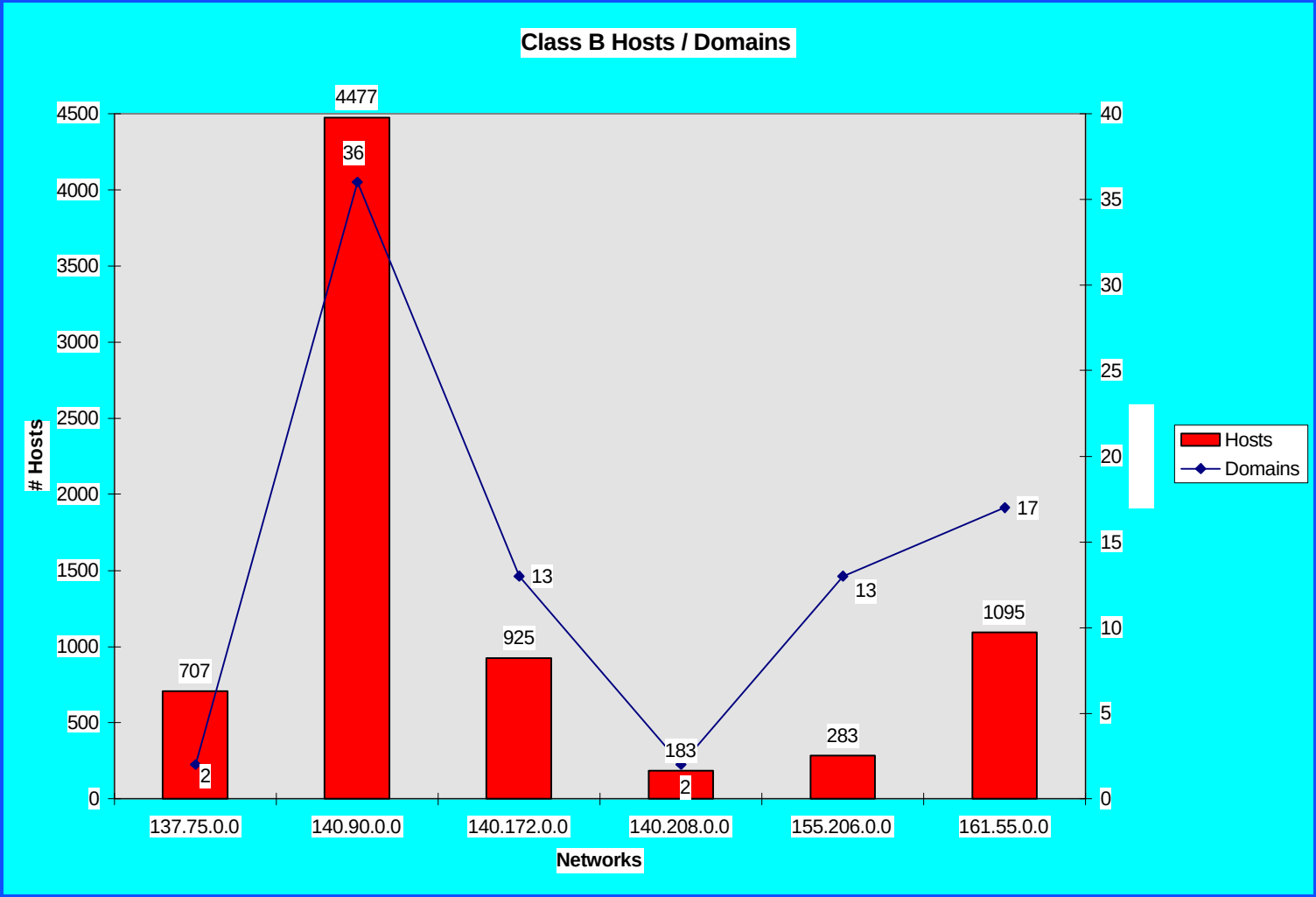
Domain Statistics

- SubDoms - # of subdomains of parent domain.
- SDHosts - # of hosts in those subdomains.
- Hosts - # of hosts in domain.
- Nets - # of unique Networks that domain hosts reside on.
- SubNets - # of unique subnets that domain hosts reside on.

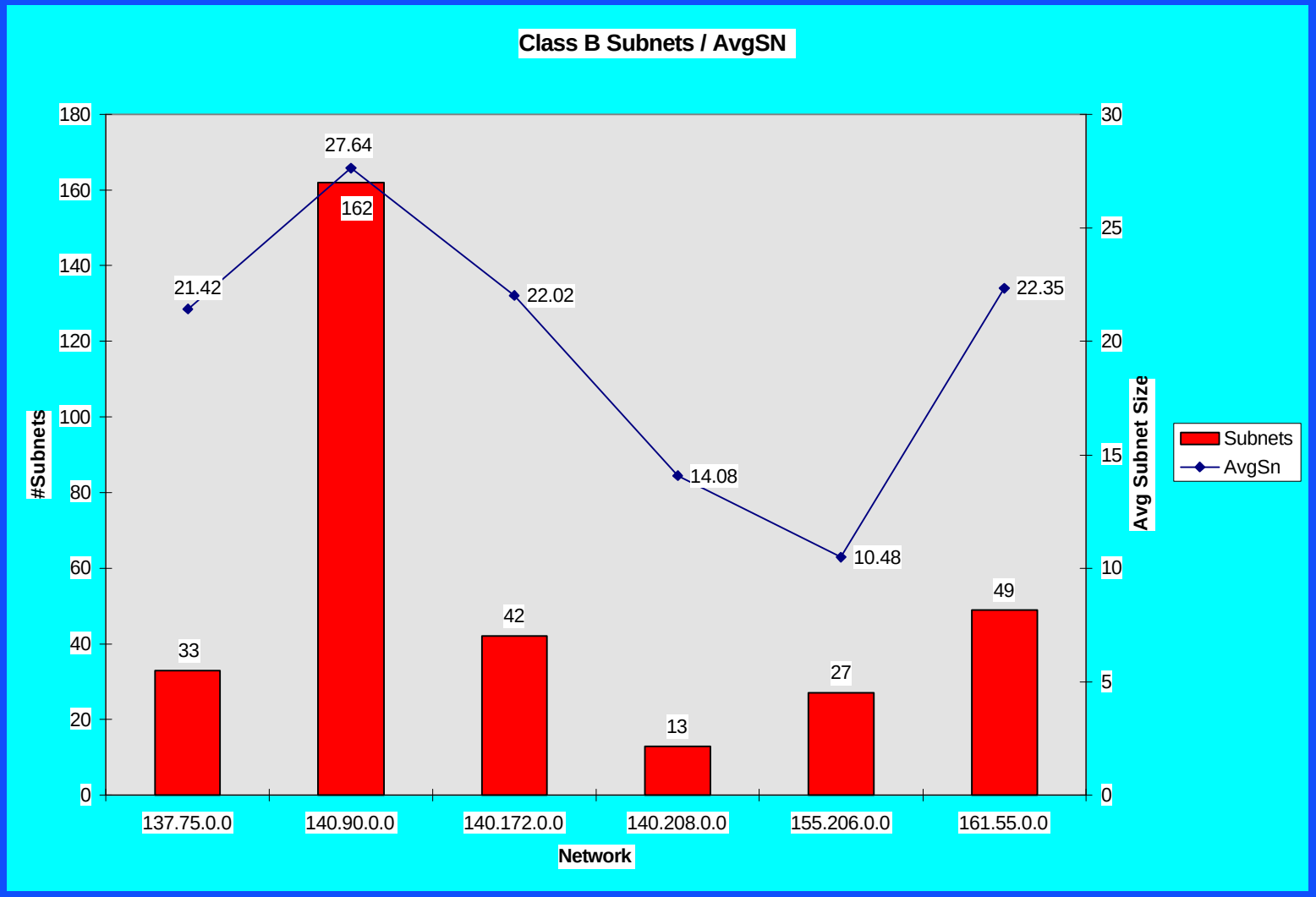
Class B Utilization



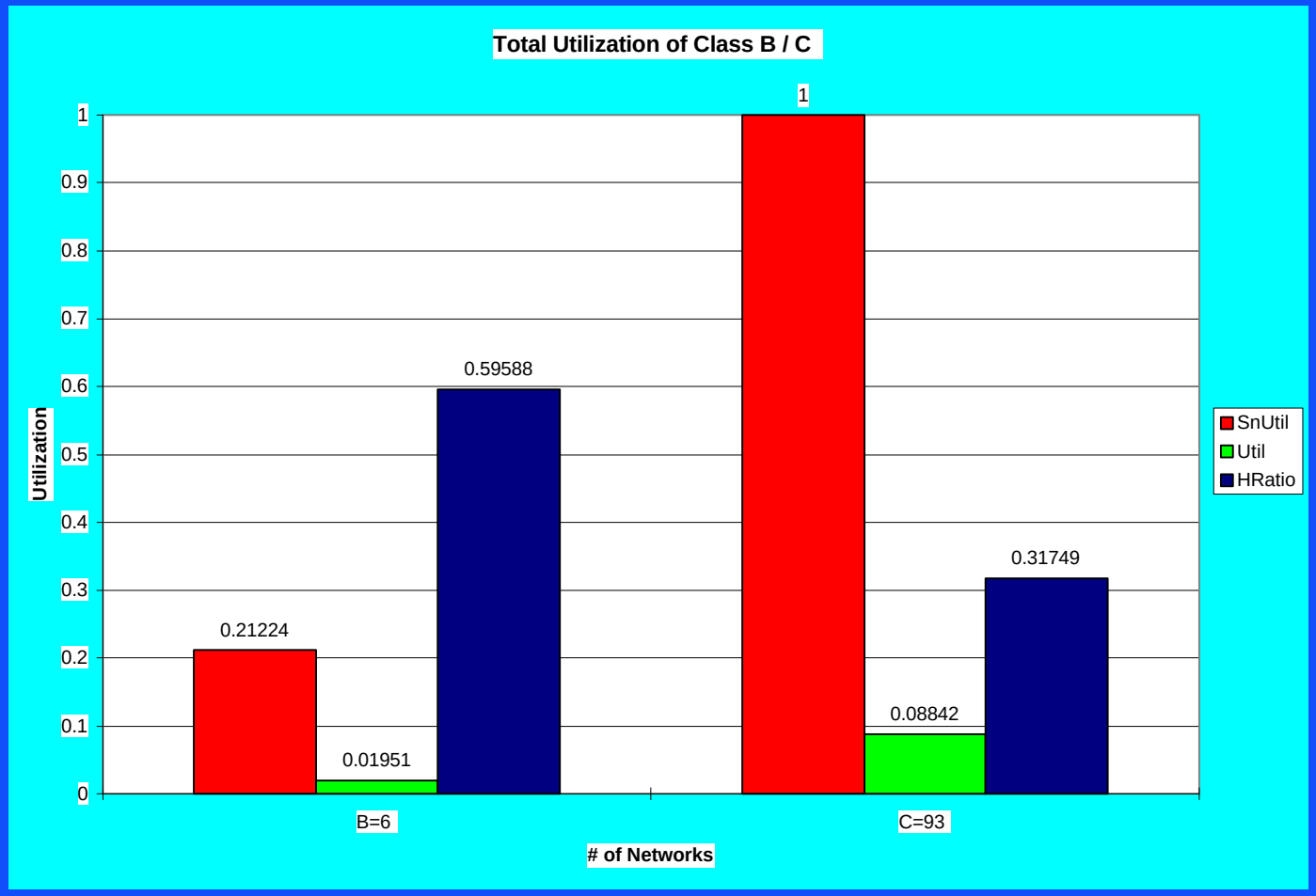
Class B Hosts / Domains



Class B Subnets / AvgSn



Comparing Bs and Cs



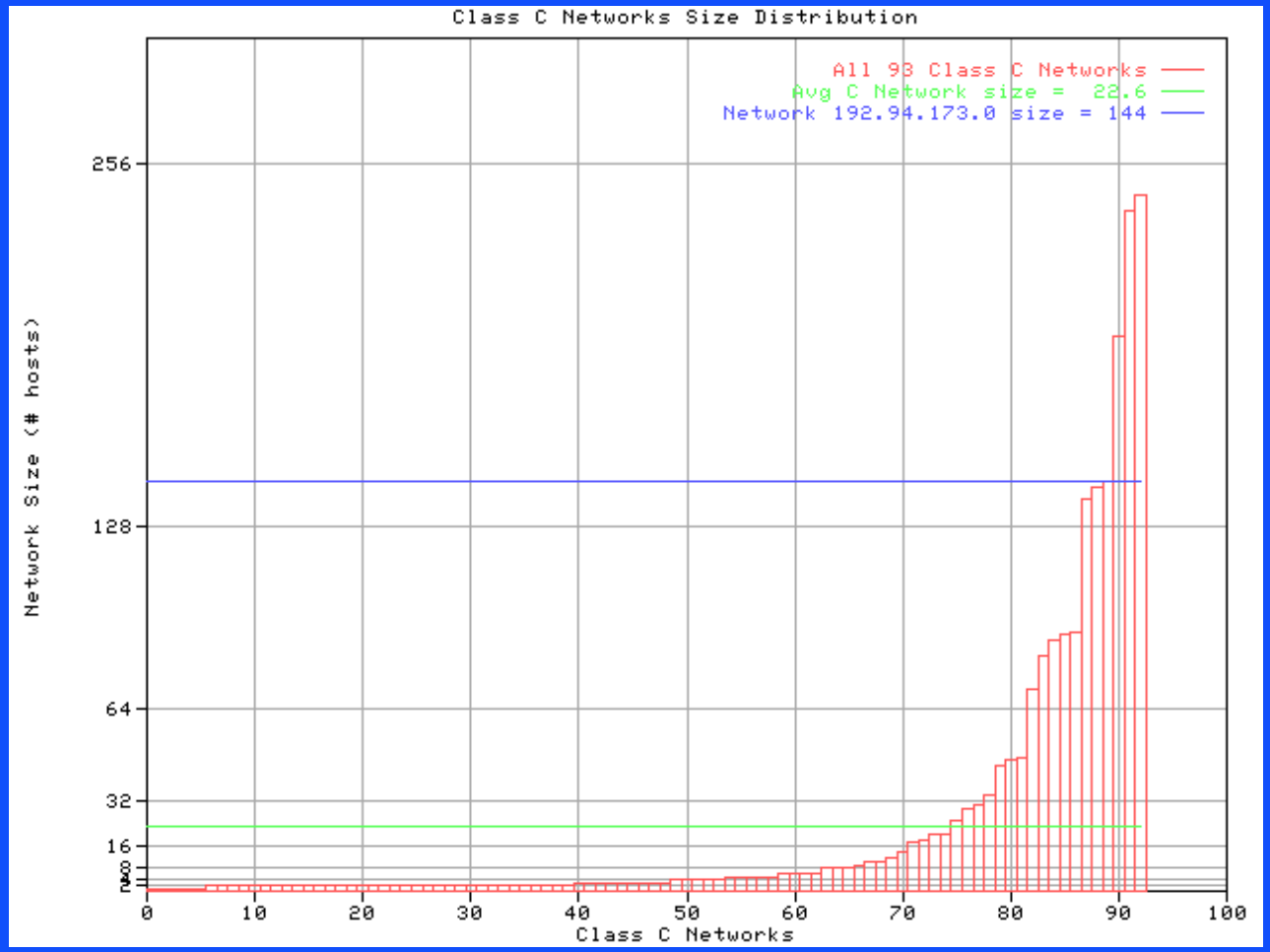
Some Observations

- The total utilization of the Class B address space is less than 2%.
- Even with the current subnet masking schemes (primarily 8/8), only 20% of the subnetwork identifiers are in use.
- Much waste is accountable to mismatch between network design and subnetting schemes. Average Class B subnet size is 24 hosts.

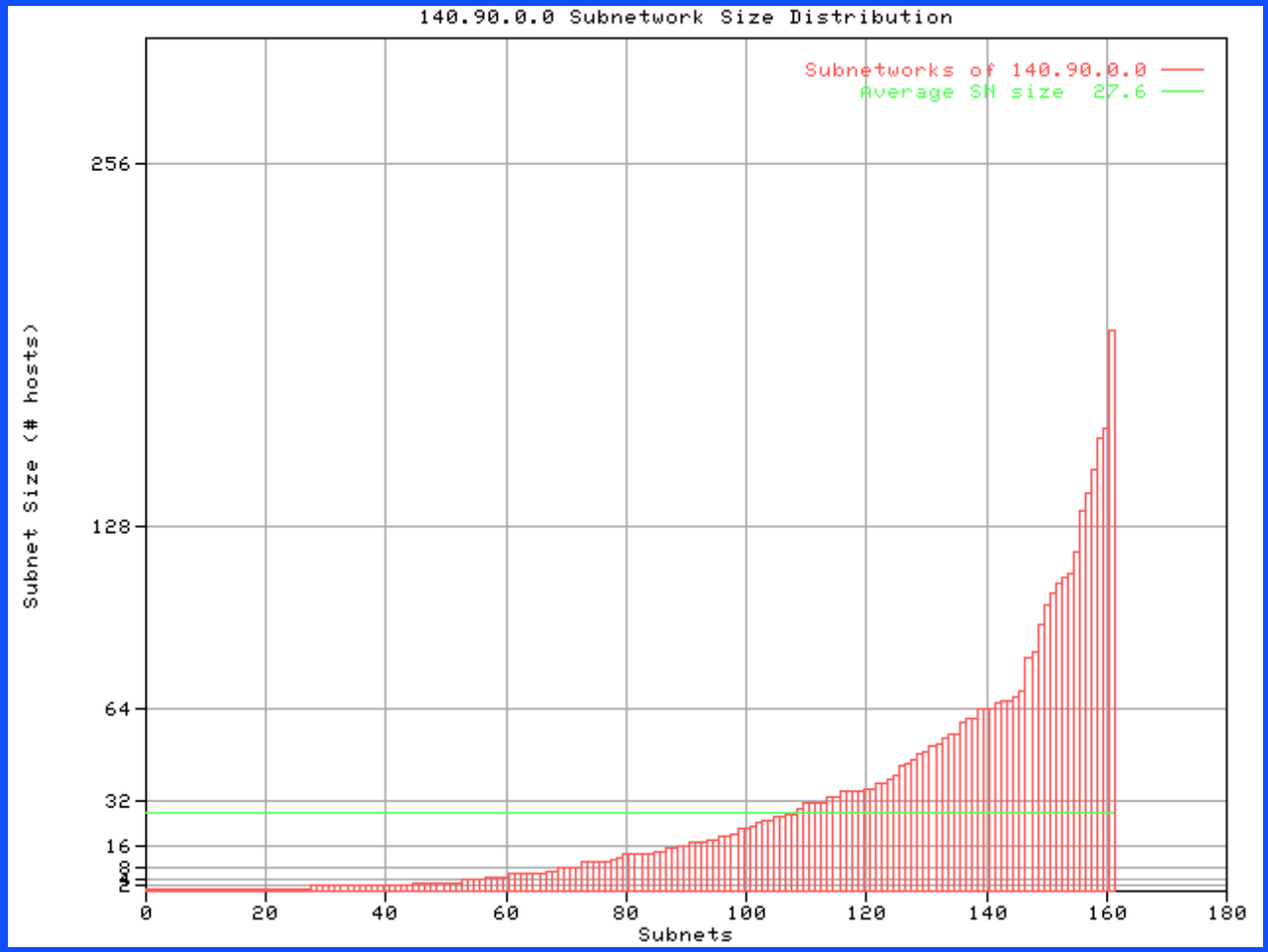
More Observations

- While Class C utilization is a bit higher (8%), this is primarily due to a few “full” nets.
- The use of Class C’s without subnetting can be very wasteful.
  - 88% of C networks have <= 64 hosts.
  - 70% have <= 8 hosts.
  - 58% have <= 4 hosts.
  - 43% seem to be pt-pt links, or DMZ’s (2 hosts)

Class C Size Distribution



The SSMC / Suitland Problem



Looking at 140.90.0.0

- Although the host address utilization is only 6%, more growth sensitive measures show an HRatio of 0.75.
- Given the current 8/8 subnetmask 140.90.0.0 has used 63% of its available subnets.
- The current raw size (4477 hosts, 36 domains) and subnet saturation level could call for a “planned” change.

Is There a Problem in DC?

- Important missing data is the growth trends and future addressing requirements for 140.90.0.0.
- If growth is flat, 63% utilization of subnet identifiers may not be a problem (~ 90 subnets left).
- If requirements for new 140.90.0.0 subnets exist, now is the time / saturation level to implement a change.

Avoiding Subnet Saturation

- The choices are simple:
  - » Make fewer logical IP subnetworks.
  - » “Make” more subnetwork identifiers.
- Fewer Subnets ==> Network redesign and some renumbering.
- More Addresses ==> Whole sale network renumbering. Network design could remain.

Network Redesign

- Average Subnet size of 140.90.0.0 is ~24 hosts.
- Are physical / logical subnets are really needed:
  - » Performance / network load.
  - » Security. Firewall / access control.
  - » Accounting.
- Collapsing some IP subnets:
  - » Performance / security / renumbering / issues.

Getting “More” Addressing

- Ask IANA for more address. This has failed numerous times in the recent past.
- Map the DC networks into a more efficient subnetting plan. The current allocation could map to:
  - 9/7 split - 6 current nets too big, 24 >= 50% saturated.
  - 10/6 split - 24 current nets too big, 52 >= 50% saturated.
  - Variable Length Subnet Masks - ? Why?

Evolving to a New SN Plan

- Remapping an operational network using its current address space is very complex.
- Migrating to a new address, relinquishing the old over time is the easiest way.
- The size (# hosts) and organizational complexity (# domains) of 140.90.0.0 requires graceful migration.
- What to do with 140.90.0.0 when we are done.

Where to Get a New Address

- IANA
  - » Not likely unless DC can “divorce” itself from the rest of NOAA addresses.
- From Current NOAA Allocations
  - » “Organizationally difficult / expensive”
- From Somewhere else ?
  - » ???

Two Proposals

- Use the Class B Assigned to the AWIPs network.
  - AWIPs by design is to be a private network.
  - Use of “Private” Class B IP Address provides the same amount of addressing.
- Exchange some addressing for the most under utilized NOAA Class B.

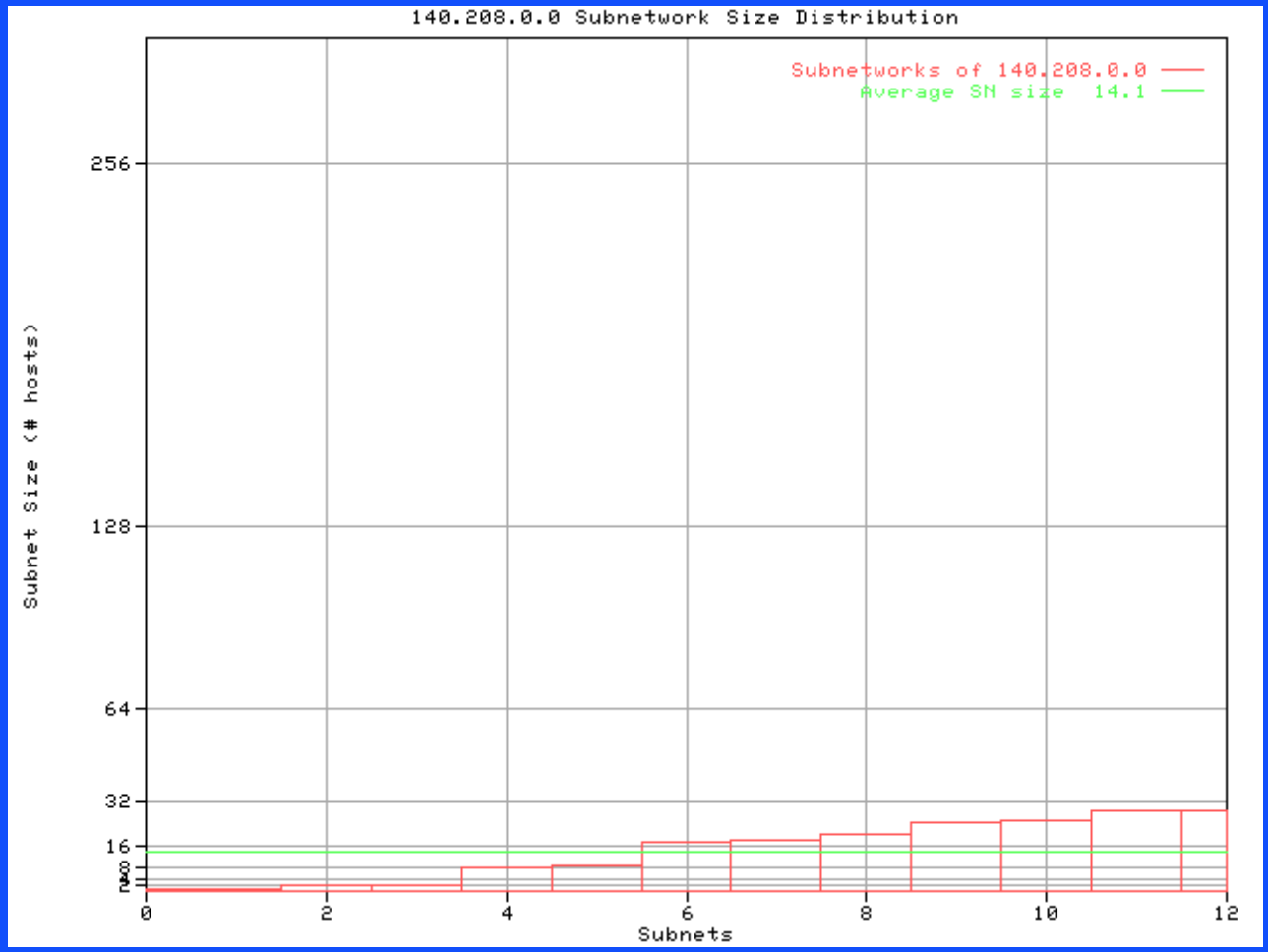
Proposal #1

- Should be discussed. AWIP's Class B is not accessible from the DNS. Thus, it is not clear what the implications (both current / operational and architectural) of private addressing would be.
- Would provide another Class B for "public" use.
- Understand the long term implications of using private addressing.

Proposal #2

- Exchange GFDL appropriate addressing in return for the eventual use of its Class B.
- Why GFDL?
  - Its it the most under utilized Class B (0.2%)
  - There are only 13 allocated subnets, none larger than 32 hosts.
  - The operational environment is less complex (only 2 domains) and seems reasonably controlled / managed.

GFDL Address Utilization



What Would GFDL Get?

- GFDL would be assigned a suitably large block of Class C addresses.
- How many / much addressing?
  - » Considering the current # and size of GFDL subnets, it appears that 8 or 16 Class C's (with the proper subnetting would be appropriate)
  - » 8 Cs with a 2/6 subnet would provide 32 / 64 (subnets/hosts). A 3/5 split would provide 64/32.
  - » 16 Cs with provide 64/64 or 32/128.

What is In it for GFDL

- Any address migration is an involved, and expensive (labor / equipment) task.
- Even though GFDL's environment seems reasonably small and well managed, it should not be their responsibility to bare the expense of a migration.
- If NOAA is capable of pooling its own resources to solve this problem, this seems the most likely choice.

The Organizational Difficulty

- There seems to be much suspicion and little cooperation among the NOAA line organizations involved in networking.
- Part of the problem seems to stem from trying to impose organizational structures on networking problems.
- Line organizations should not “own” addressing. Organizational hierarchies are usually not isomorphic to networking structures.